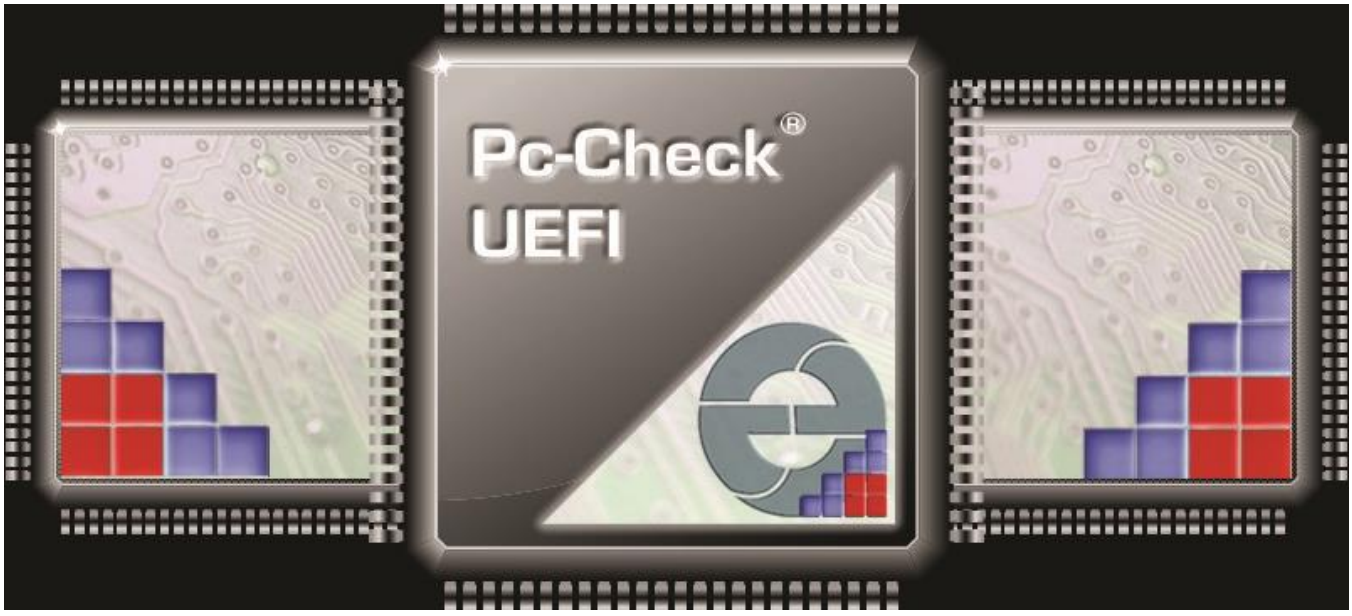
Eurosoft

Computer reliability solutions

Pc-Check® UEFI

Test Descriptions

Professional, computer diagnostic software, fully UEFI-native pre-boot



Assuring direct, legacy-free UEFI hardware testing

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Eurosoft PC Reliability Solutions

Pc-Check UEFI Test Descriptions

EDFTD V10.8-UEFI

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Introduction

The purpose of the Pc-Check UEFI Test Descriptions manual is to provide you with an understanding of the specifics involved in running Test Modules. The test descriptions include information about each of the tests, test settings (parameters), error codes that may be returned and possible causes of failure.

This document is provided separately as the test modules are an independent deliverable to be used as part of a program. These use the same test descriptions: however, they have different user interfaces and functionality.

Not all components may be supplied with every product.

Document Structure

The first table that follows lists each Test Group, number and name, and the tests it can provide. Tests requiring Eurosoft test hardware are indicated with an (L) after the test name. Interactive tests (which must be run in interactive mode) are indicated with an (I).

The next table lists general System Error Codes that may be returned by the tests. i.e. 0x02/3FF.

These Error Codes are made up of two parts; the first part is unique within the Diagnostic Group and is the identifier for the error, this error identifier will never change for a given error within a group. The second part is the Extra Information type that states the format of any extra information associated with an error code when it occurs. The extra information types are listed in the Extra Information Codes section of this document.

The test descriptions in the following sections are arranged numerically by group number and conform to a uniform generic structure. Each section starts with a general overview of the group and the devices it contains. Following this is a table that lists all the tests in the group and summarises the main requirements for the test to run. An '•' in the 'I' column indicates the test must be run in Interactive mode as it requires operator interaction or feedback. An '•' in the 'E' column indicates that specific Eurosoft hardware (i.e. a loopback plug) is required to run the test. An 'M' indicates a media requirement.

The next table 'Parameters' lists, for each test that has them, the available parameters, their Default, Minimum and Maximum values and any explanatory notes. In order to avoid unnecessary duplication notes are only given against the first occurrence of the parameter in the table. In some parameters the default or limit may depend on the specific system under test, in these cases the value is given as 'SDP' (System Dependant Parameter).

Following Parameters are the individual test descriptions which generally also include an estimate of how long the test will take to run.

Finally for each group there are two tables giving the group specific error codes that the tests may return and a 'Troubleshooting' table that lists possible causes of the errors.

Note: For some parameters the maximum value may be defined as MAX_PATH. This is a system defined value of the maximum length of a file name and path and is normally 260 characters.

Note: For Boolean parameters and relevant system information, 1 represents True and 0 represents False.

Note: Each Group ID for EFI ends with a 2. This differentiates the platform from Windows tests, which use 0 and 1 (32 or 64 bit).

Platforms

The Pc-Check UEFI diagnostics requires 64 bit UEFI of revision 2.31 or greater, SMBIOS version 2.7 or greater.

Test Results

The overall result of each test will be one of five values:

- Passed: the test ran to completion and no error was found.
- Failed: the test ran but an error was found either with the hardware or an operator selected a Fail.
- Skipped: the test was skipped by the operator.
- Aborted: the test was aborted by the operator.
- Not Available: the system has determined the test cannot be run. The hardware is not present or the test parameters are out of scope.

If ‘Failed’ or ‘Not Available’ the error code will give details of the cause of the failure or the reason the test was not available.

Note: Some tests will populate extra information when a test completes. Where the extra information returns a completed proportion of the device, the Decimal System is used when converting between multiples of units i.e. a KB is 1000 Bytes. Only in the case of Memory the Binary System is used i.e. a KB is 1024 Bytes.

Test Group	Group Name	Tests
702	Motherboard	401 - Memory Buses 402 - PCI Buses 403 - Disk Buses
1002	Memory	401 - Seating 402 - Quick 403 - Pseudo Random Data 404 - Pseudo Random Address 405 - Inversion Tree 406 - Stride 407 - Block Rotation 408 - Microtopology
2202	Network	401 - Ping Test 402 - Register Test 403 - ICMP (L)
2602	Hard Drives	401 - S.M.A.R.T. Immediate Test 402 - Butterfly Seek 403 - Random Read 404 - Linear Read 405 - S.M.A.R.T. Short Self Test 406 - S.M.A.R.T. Extended Self Test 407 - S.M.A.R.T. Conveyance 408 - Standby 409 - Non-Destructive Write 410 - Internal Cache
3102	USB	401 - Quick Test (L) 402 - NRZI Max Bit Stuffing (L) 403 - NRZI Glitch Zero (L) 404 - NRZI Line Oscillation Type 1 (L) 405 - NRZI Line Oscillation Type 2 (L) 406 - NRZI Line Oscillation Type 3 (L) 407 - NRZI Line Oscillation Type 4 (L) 408 - Max Disparity (L) 409 - Random Data (L)
3502	Monitor	401 - Panel Test (I)
4502	Serial Ports	401 - Line Control 402 - Handshake (L) 403 - External Loopback (L) 404 - Internal Loopback 405 - FIFO (L) 406 - Divisor Clock 407 - Endurance (L)

Test Group	Group Name	Tests
5502	Processor	401 - Core Instruction Set 402 - Floating Point Instruction Set 403 - SSE Instruction Set Test 404 - SSE2 Instruction Set Test 405 - SSE3 Instruction Set Test 406 - SSSE3 Instruction Set Test 407 - SSE4 Instruction Set Test 409 - Pairing Symmetry 410 - Execution Symmetry 411 - Cache Coherency
6202	Optical	401 - Linear Read 402 - Random Read 403 - Butterfly Seek
7002	Solid State Drives	401 - Linear Read 402 - Random Read 403 - S.M.A.R.T. Immediate Test 404 - S.M.A.R.T. Short Self Test 405 - S.M.A.R.T. Extended Self Test 406 - Internal Cache 407 - S.M.A.R.T. Conveyance
7702	System Block Device	401 - Linear Read 402 - Random Read
7802	NVMe Drives	401 - Linear Read 402 - Random Read 403 - Internal Cache 404 - S.M.A.R.T Health Test

System Error Codes

Error Code	Name
0x30/3FF	Memory Allocation Error
0x31/3FF	Parameter read error
0x32/3FF	Parameter validation error
0x33/3FF	This test is not available on your OS
0x34/3FF	This test requires interactive mode
0x35/3FF	The specified test was not found
0x37/3FF	No testable devices were detected
0x38/3FF	Attribute read error
0x39/3FF	Test run failure

Extra Information Codes

Extra Code	Description
002	Loop-back or Eurosoft hardware Detected during testing
003	Percentage achieved during testing
004	Address location of error
005	Drive position for error
006	Read or Write transfer over or under
009	Core that has failed
00A	Media size returned
00B	Failed transfer speed
010	Serial port specific error
015	S.M.A.R.T. failed attribute
016	Speed that was outside tolerance
017	Time that was outside tolerance
019	Temperature when failing
080	Test general setting specific to test and relevant to parameter and error e.g battery charge failure would equal charge value
090	Stress specific - Device Identity in top 4 bytes. Windows Exception code in bottom 32 bits
091	Stress specific - Device Identity in top 4 bytes. No other extra.
092	Stress specific - Device Identity in top 4 bytes. Windows standard error in bottom 32 bits
3FF	No extra information and last error to be used

702 - Motherboard

Overview

This group tests the motherboard, sometimes referred to as the mainboard or logic board.

Usually the largest printed circuit board in a PC, the motherboard provides connections between all the various parts of the system. These connections are collectively known as buses (for example, the PCI bus).

Note: Increasingly the motherboard also provide functions that traditionally would be handled by plug in cards and modules. If you do not see a test for a component that you expected to find in this group, it may have been sophisticated enough to require a group of its own or has been placed within the group of the peripheral it supports.

Tests

Test	Name	I	E	M	T
401	Memory Buses				
402	PCI Buses				
403	Disk Buses				

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	1	Duration	15	6	604800	How long to run the test in seconds
402	1	Duration	15	6	604800	
403	1	Duration	15	6	604800	

Descriptions

401 - Memory Buses

Tests the memory bus for susceptibility to capacitive, inductive or conductive crosstalk at different transaction frequencies.

Test Time: 16s

402 - PCI Buses

Tests the PCI bus for susceptibility to capacitive, inductive or conductive crosstalk at different transaction frequencies.

Test Time: 16s

403 - Disk Buses

Tests the disk bus for susceptibility to capacitive, inductive or conductive crosstalk at different transaction frequencies.

Test Time: 16s

Error Codes

Error Code	Name
0x00/3FF	The test cannot be executed because something is not supported
0x01/3FF	Memory bus noise and harmonic resilience test failed
0x02/3FF	Non-Specific motherboard test failure
0x03/3FF	PCI bus noise and harmonic resilience test failed
0x04/3FF	Disk bus noise and harmonic resilience test failed

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF 0x01/3FF 0x02/3FF 0x03/3FF 0x04/3FF	No capabilities to perform the test.

1002 - Memory

Overview

This is a group that tests physical memory (RAM).

Different testing algorithms are used by which to reveal the faulty behaviour of prone memory modules. Memory testing is a probabilistic process that seeks to discover problems that could lead to data or program corruption in normal operation. The number of possible combinations of data and timing are near infinite, so most test algorithms seek to isolate problems though proven methods and careful design based on the physical characteristics of the manufacturing design - for example physically adjacent bit cells are more likely to show coupling effects.

Note: 1. If testing with a duration, for all tests this should be at least a minute.

Note: 2. In this test group it is possible to combine the duration and coverage parameters. i.e. you can test 50% of memory for 60 minutes.

Note: 3. Identify the failing module by matching the 'handle' value of the device in the system information log with the value given in the test failure code of the result log.

Tests

Test	Name	I	E	M	T
401	Seating				
402	Quick				
403	Pseudo Random Data				
404	Pseudo Random Address				
405	Inversion Tree				
406	Stride				
407	Block Rotation				
408	Microtopology				

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	1	Duration	0	0	604800	How long to run the test in seconds or specify zero if testing by coverage alone (default).
	2	Coverage	100	1	100	Percentage of available memory to test.
402	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
	4	Data Pattern	0xCCCCCCCCCCCCCCCC	0x0	0xFFFFFFFFFFFFFFFF	Data pattern used for test (Hexadecimal value).
403	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
	3	Pseudo Random Seed	0x0	0x0	0xFFFFFFFFFFFFFFFF	Seed used for initialising the Pseudo random number generator.
404	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
	3	Pseudo Random Seed	0x0	0x0	0xFFFFFFFFFFFFFFFF	
405	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
406	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
407	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
408	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
	3	Pseudo Random Seed	0x0	0x0	0xFFFFFFFFFFFFFFFF	

Descriptions

401 - Seating

Exercises the address and data lines to ensure proper seating of memory modules in a quick to execute test.

Test Time: Approx 1.5s per GB

402 - Quick

Writes user specified fixed pattern into memory (default 0xC repeated across 64 bits) and verifies that it was stored correctly.

Test Time: Approx 0.5s per GB

403 - Pseudo Random Data

Writes pseudo-random patterns into memory and verifies that they were stored correctly.

Test Time: Approx 1s per GB

404 - Pseudo Random Address

Writes pseudo-random data to pseudo-random addresses using a sequence generated with the start seed value. After memory is filled with data, the sequence is repeated to verify memory stored the values correctly.

Test Time: Approx 3s per GB

405 - Inversion Tree

Set bits to 1 or 0 with increasing frequency such that over time they would form a tree pattern.

Test Time: Approx 7s per GB

406 - Stride

Writes a test pattern across memory with a variable stride, then tries to disrupt the stored pattern with writes to other memory not included in the first pass.

Test Time: Approx 36.5s per GB

407 - Block Rotation

Writes a test pattern to blocks of memory, each time rotated in respect to each other. Checks that these values are correctly stored.

Test Time: Approx 10s per GB

408 - Microtopology

Uses an advanced mathematical principle to manipulate physically adjacent cells even if the true topology of the memory modules is unknown. This test can also detect timing and noise issues in the memory system as a whole. The longer this test can run, the greater the probability of finding a fault.

Test Time: Approx 7.5m per GB

Error Codes

Error Code	Name
0x00/3FF	Mismatch of memory
0x01/3FF	Memory allocation failure

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF	The memory appears to be faulty.
0x01/3FF	There was an error while preparing to run the test.

2202 - Network

Overview

This is a test group for Network Interface Cards. A Network Interface Card (NIC, also known as a Network Interface Controller, network adapter, LAN adapter, and by similar terms) is a computer hardware component that connects a computer to a computer network such as Ethernet, WIFI or Token Ring. This provides a base for a full network protocol stack, allowing communication among small groups of computers on the same local area network (LAN) and large-scale network communications through routable protocols, such as Internet Protocol (IP).

NIC diagnostics are done through register testing as well as packet send and receive sequence verification through standard NIC tests known as Ping tests. Register tests and simple Ping tests are hardware internal tests, simple Ping is done through PHY loopback. ICMP Ping test is an IP based ICMP Ping test which can be configured to run a loop back ping on same NIC or an external ICMP to a remote machine.

Note: The network stack MUST be enabled from UEFI BIOS Setup to run tests from this group.

Note: Register test and simple Ping testing does not require any configuration, or additional cabling. ICMP Ping requires either a loopback plug (internal Ping) or suitable cabling to connect a network (external ping). To ping a remote system, both the tested and remote systems should be on same subnet else the reply will time-out. A gateway address should also be specified in the test attributes, even if there is no gateway machine present, as this is required for configuration.

Tests

Test	Name	I	E	M	T
401	Ping Test				
402	Register Test				
403	ICMP		•		

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
403	1	Source IP	0	0	0	Source IP address.
	2	IP Subnet mask	0	0	0	Network subnet mask.
	3	Destination IP	0	0	0	Destination IP address.
	4	Gateway IP	0	0	0	Gateway address.
	5	ICMP Send Count	0	1	100	How many times to retry send.

Descriptions

401 - Ping Test

The Ping Test is a loopback ping test which does not require any configuration. The Ping test is carried through internal PHY loopback if it is supported by the built in NIC card and firmware driver.

Test Time: 1s

The ICMP Ping Test uses the IP stack and is based on ICMP protocol. The test uses network ping to test NIC internally, or can ping an external machine to test send and receive. It requires loop back plug to ping NIC itself and a common network cable to ping an external remote machine.

The ICMP Ping Test assigns the test machine an IP address which should be provided through test parameters. For loopback ping, the source and destination IP must be the same address. To ping a remote machine, the source IP must be from the same subnet as that of the remote machine. A gateway IP must be provided in configuration file even if a gateway is present or not in the network.

Test Time: 1s

402 - Register Test

The Register Test is register read and write test which does not require additional configuration. Most common registers are tested, it is a firmware NIC driver test.

Test Time: 1s

403 - ICMP

The ICMP Ping Test uses the IP stack and is based on ICMP protocol. The test uses network ping to test NIC internally, or can ping an external machine to test send and receive. It requires loop back plug to ping NIC itself and a common network cable to ping an external remote machine.

The ICMP Ping Test assigns the test machine an IP address which should be provided through test parameters. For loopback ping, the source and destination IP must be the same address. To ping a remote machine, the source IP must be from the same subnet as that of the remote machine. A gateway IP must be provided in configuration file even if a gateway is present or not in the network.

Test Time: 1s

Error Codes

Error Code	Name
0x00/3FF	The test cannot be executed because a required feature is not supported.
0x01/3FF	Loopback plug or cable not attached.
0x02/3FF	IP v4 conversion error. IP address in configuration file is not in correct format.
0x03/3FF	IP instance creation error. Test failed to initialize due to a general failure.
0x04/3FF	ICMP receive error detected.
0x05/3FF	ICMP send error detected. NIC failed to send data.
0x06/3FF	Event timer error. Failed to create timer due to a general error.
0x07/000	Parsing error while trying to read test parameters.
0x08/3FF	Network card has a permanent address, which can't be changed.
0x09/3FF	Network card failed to configure. General Error.
0x0A/3FF	Network reply timed out. Something is wrong with the network card, plug or network cable.

Troubleshooting

Error Code(s)	Potential Reason
0x02/3FF 0x03/3FF 0x04/3FF 0x05/3FF 0x06/3FF 0x08/3FF 0x09/3FF 0x0A/3FF	The device may be faulty. Check that all prerequisites were met correctly.
0x00/3FF 0x01/3FF	For loopback test, plug is not attached or it is faulty. For remote ICMP ping, cable is not attached, or cable has a fault.
0x07/000	Configuration parameter is incorrect.

2602 - Hard Drives

Overview

This group tests Hard Drives. Hard Drives consist of one or more rigid (hence "hard") rapidly rotating discs, coated with magnetic material and with magnetic heads arranged to write data to the surfaces and read it from them.

Tests are available to verify the head actuator mechanism, reliability of the recording medium, report the S.M.A.R.T. status, and possibility of imminent drive failure. You can also run the manufacturer's built in self tests.

Note: Hard Drives offer large storage capacities. A coverage of 100% will exhaustively test all parts of the media, but will also take a long time to complete.

Tests

Test	Name	I	E	M	T
401	S.M.A.R.T. Immediate Test				
402	Butterfly Seek				
403	Random Read				
404	Linear Read				
405	S.M.A.R.T. Short Self Test				
406	S.M.A.R.T. Extended Self Test				
407	S.M.A.R.T. Conveyance				
408	Standby				
409	Non-Destructive Write				
410	Internal Cache				

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	5	S.M.A.R.T Diagnostic Threshold	100	1	10000	Specifies the maximum permitted error count in the comprehensive S.M.A.R.T error log.
	6	Ignore S.M.A.R.T Error Log	FALSE	FALSE	TRUE	Specifies any error count in the comprehensive S.M.A.R.T error log will be ignored.
402	1	Duration	0	0	604800	How long to run the test in seconds
	2	Coverage	100	1	100	Percentage of total capacity to test
	3	Maximum Errors	1	1	50	Continues to test until the maximum number of errors is reached. These are only errors directly associated with reading the drive.
403	1	Duration	300	1	604800	
	3	Maximum Errors	1	1	50	
404	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
	3	Maximum Errors	1	1	50	
409	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
	3	Maximum Errors	1	1	50	

Descriptions

401 - S.M.A.R.T. Immediate Test

A "threshold exceeded" value is intended to indicate that there is a relatively high probability that the drive will not be able to honour its specification in the future: that is, it's "about to fail". The predicted failure may be catastrophic, or may be something as subtle as inability to write to certain sectors, or slower performance than the manufacturer's minimum.

Test Time: 2 to 10s

402 - Butterfly Seek

Each Butterfly Seek test iteration consists of two seeks: one seek is lower than (below) the middle sector and one seek is higher than (above) the middle sector. After each iteration, the lower seek position increases and the higher seek position decreases by the same amount.

Test Time: 8.4 to 12.1 minutes per GB with Duration

403 - Random Read

Each Random Seek test iteration is one seek to a pseudo random sector position. The purpose of this test is to test the head actuator mechanism, not the read head mechanism; so the actual sectors that are read, and even the accuracy of the data found, are not necessarily relevant. For this reason, it does not matter if the pseudo-random generator produces the same sector to check each time the test is run.

Test Time: 7.3 to 10.8 minutes per GB with Duration

404 - Linear Read

Each Read Verify test iteration is one seek and verify. Each iteration, the seek position increases by one sector increment.

Test Time: 1.5 to 6 minutes per GB with Duration

405 - S.M.A.R.T. Short Self Test

This test launches and monitors a S.M.A.R.T. Short Self-Test.

This test checks the electrical and mechanical performance as well as the read performance of the disk.

Electrical tests might include a test of buffer RAM, a read-write circuitry test, or a test of the read-write head elements.

Mechanical test includes seeking and servo on data tracks. Scans small parts of the drive's surface. Checks the list of pending sectors that may have read errors.

Test Time: Approx 2 minutes.

406 - S.M.A.R.T. Extended Self Test

This test launches and monitors a S.M.A.R.T. Extended Self-Test.

A longer and more thorough self-test which scans the entire disk surface, with no time limit.

This test may take many hours to complete.

Test Time: Hundreds of minutes, this is device dependent. Approximately one gigabyte per minute for modern drives.

407 - S.M.A.R.T. Conveyance

This test launches and monitors a S.M.A.R.T. Conveyance Self-Test

Intended as a quick test to identify damage incurred during transporting of the device from the drive manufacturer to the computer manufacturer.

Test Time: Several minutes but is device dependent.

408 - Standby

This test puts the drive into low power mode in which the spinning disk media is brought to a stop. The drive is then 'spun up' and accessed for data. This process is monitored for problems.

409 - Non-Destructive Write

Tests the drives ability to reliably write data. Each Non-Destructive Write test iteration first reads the existing data from the disk region to be tested. The disk region is then over written with test data, verified and finally the original data is restored. In the event of failure, the test will always try to restore the original data many times over before ending. Each iteration, the seek position increases by one sector increment.

Test Time: 6 to 24 minutes per GB with Duration

410 - Internal Cache

Tests the Hard Drive Internal Cache or Buffer Memory.

Test Time: 10s

Error Codes

Error Code	Name
0x00/3FF	Device ID unknown (Exceeds array depth)
0x01/3FF	Device is too small to test
0x02/3FF	Device read failed
0x03/3FF	S.M.A.R.T. interface not supported
0x04/3FF	S.M.A.R.T. disabled or not supported by device
0x05/3FF	S.M.A.R.T. failed
0x06/3FF	Requested S.M.A.R.T. test not supported by device
0x07/3FF	Standby immediate test failed
0x08/3FF	Device write failed
0x09/3FF	Read written data mismatch
0x0A/3FF	A S.M.A.R.T. attribute reached or below the acceptable threshold value
0x0B/3FF	A S.M.A.R.T. comprehensive log error count at or exceeding the acceptable limit

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF 0x01/3FF 0x02/3FF 0x04/3FF 0x05/3FF 0x07/3FF 0x08/3FF 0x09/3FF 0x0A/3FF 0x0B/3FF	The device may be faulty. Errors on the hard drive can be caused by power loss.
0x03/3FF 0x06/3FF	The device does not appear to support this test. Check the test descriptions manual for the test requirements.

3102 - USB

Overview

This group is for Universal Serial Bus (USB). USB is a specification for the cables, connectors and protocols that provide convenient and flexible serial communication with connected devices at a variety of speeds. It is typically used to connect external peripheral devices ranging from a mouse to a back-up storage solution.

This group is only available if Eurosoft USB hardware is detected when the program initialises. It will not be available if there are no suitable USB devices connected to the USB ports.

Each device identified by this group corresponds to a Eurosoft USB Test Device or Eurosoft Program Device. It is not however this device which is tested, but the connectivity to it, comprising of controllers, traces, cabling and port.

Note: This test group requires enhanced Eurosoft USB Test or Program Devices, earlier Eurosoft USB Test Devices are not recognised in the UEFI product. The required plug type can be recognised by the presence of a file system partition.

Note: Devices should not be removed or inserted while diagnostics are running.

Tests

Test	Name	I	E	M	T
401	Quick Test		•		
402	NRZI Max Bit Stuffing		•		
403	NRZI Glitch Zero		•		
404	NRZI Line Oscillation Type 1		•		
405	NRZI Line Oscillation Type 2		•		
406	NRZI Line Oscillation Type 3		•		
407	NRZI Line Oscillation Type 4		•		
408	Max Disparity		•		
409	Random Data		•		

Parameters

Descriptions

401 - Quick Test

A short test providing a rapid means to assess basic USB port functionality. Use the other tests provided to test port reliability.

Test Time: 5 to 10 seconds

402 - NRZI Max Bit Stuffing

NRZI Max Bit Stuffing Test. Hi-speed data transfers self-clock using transitions contained within the data transmitted. The encoding method is called non-return-to-zero-inverted (NRZI) encoding. To ensure sufficient transitions, additional bits are added, known as bit stuffing. This test creates the conditions where the maximum use of bit stuffing is required.

Test Time: 1 to 3 minutes

403 - NRZI Glitch Zero

NRZI Glitch Zero Test. Hi-speed data transfers self-clock using transitions contained within the data transmitted. The encoding method is called non-return-to-zero-inverted (NRZI) encoding. To ensure sufficient transitions, additional bits are added, known as bit stuffing. This test uses a stable stream of maximum bit stuffed data with randomly occurring zeros.

Test Time: 1 to 3 minutes

404 - NRZI Line Oscillation Type 1

NRZI Line Oscillation Type 1 Test. Hi-speed data transfers self-clock using transitions contained within the data transmitted. The encoding method is called non-return-to-zero-inverted (NRZI) encoding. This test uses a data pattern to set up a square wave oscillation within the data encoding. This tests for susceptibility to capacitive, inductive or conductive crosstalk. Each test type exploits a different frequency of oscillation.

Test Time: 1 to 3 minutes

405 - NRZI Line Oscillation Type 2

NRZI Line Oscillation Type 2 Test. Hi-speed data transfers self-clock using transitions contained within the data transmitted. The encoding method is called non-return-to-zero-inverted (NRZI) encoding. This test uses a data pattern to set up a square wave oscillation within the data encoding. This tests for susceptibility to capacitive, inductive or conductive crosstalk. Each test type exploits a different frequency of oscillation.

Test Time: 1 to 3 minutes

406 - NRZI Line Oscillation Type 3

NRZI Line Oscillation Type 3 Test. Hi-speed data transfers self-clock using transitions contained within the data transmitted. The encoding method is called non-return-to-zero-inverted (NRZI) encoding. This test uses a data pattern to set up a square wave oscillation within the data encoding. This tests for susceptibility to capacitive, inductive or conductive crosstalk. Each test type exploits a different frequency of oscillation.

Test Time: 1 to 3 minutes

407 - NRZI Line Oscillation Type 4

NRZI Line Oscillation Type 4 Test. Hi-speed data transfers self-clock using transitions contained within the data transmitted. The encoding method is called non-return-to-zero-inverted (NRZI) encoding. This test uses a data pattern to set up a square wave oscillation within the data encoding. This tests for susceptibility to capacitive, inductive or conductive crosstalk. Each test type exploits a different frequency of oscillation.

Test Time: 1 to 3 minutes

408 - Max Disparity

Max Disparity Test. SuperSpeed transfers self-clock using transitions contained within the data transmitted. The encoding method is 8b/10b encoding. For every 8 bits of original data, 10 bits are transmitted so as to ensure that sufficient transitions occur for the clock to be recovered and that the electrical properties of the signal are optimal. This test randomly combines data those bit patterns that produce the most running disparity in the encoded signal.

Test Time: 1 to 3 minutes

409 - Random Data

Random Data Test. Transfers random data and ensures that the transfers complete accurately without data corruption.

Test Time: 1 to 3 minutes

Error Codes

Error Code	Name
0x00/3FF	The test cannot be executed because something is not supported
0x01/3FF	The specific test is unavailable
0x02/3FF	A read error occurred
0x03/3FF	The specific USB test failed

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF 0x01/3FF 0x02/3FF 0x03/3FF	No capabilities to perform the test.

3502 - Monitor

Overview

This group test the video display panel or monitor.

Displays a series of images to assist in determining the correct operation of the display panel or monitor. Look for issues such as dead pixels and faulty colour channels.

Note: UEFI pre-boot supports only one monitor which is the default monitor at boot.

Tests

Test	Name	I	E	M	T
401	Panel Test	•			

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	1	Maximum Horizontal Resolution	0	0	32000	Maximum horizontal resolution for display of test patterns. Use this to limit resolution if BIOS offers modes beyond capability of the panel.

Descriptions

401 - Panel Test

This test is an interactive test which presents various screen test patterns. The operator must assess carefully the display to identify dead pixels or poor colour representation. The operator must press a key to proceed to the next test pattern. If no input is received for approximately one minute, the test will end automatically. At the end of the test, the operator shall be asked if the display seemed correct.

Test Time: Approx 1 minute.

Error Codes

Error Code	Name
0x00/3FF	The test cannot be executed because something is not supported
0x01/3FF	Test declared as failed by operator
0x02/3FF	Failed so set graphics mode selected from resolutions
0x03/3FF	Failed to restore original video mode

Troubleshooting

Error Code(s)	Potential Reason
0x01/3FF	The display panel was declared faulty by the operator.
0x00/3FF 0x02/3FF 0x03/3FF	No capability to perform the test or a firmware issue affected proper test operation.

4502 - Serial Ports

Overview

This group tests serial ports. A serial port (sometimes called a COM port) is a physical interface through which information transfers in or out one bit at a time according to the RS-232 standard. Tests are provided to verify the functionality of the serial ports as they transmit data and receive data, manipulate various control signals or set different transmission (baud) rates.

Each device identified by this group is a serial port.

Note: Serial port hardware is available in almost every PC system, but external connections are often missing. Similarly, multi-port extender cards may feature internal headers for additional backplates that may not be installed. It is not possible for software to detect if ports have external connections.

Tests

Test	Name	I	E	M	T
401	Line Control				
402	Handshake		•		
403	External Loopback		•		
404	Internal Loopback				
405	FIFO		•		
406	Divisor Clock				
407	Endurance		•		

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
407	1	Duration	300	1	604800	How long to run the test in seconds
	2	BAUD	57600	300	115200	BAUD rate at which to test. If the UART being tested is overclocked the BAUD rate will be increased proportionally.

Descriptions

401 - Line Control

Test the serial port line control.

Test Time: Up to 20s

402 - Handshake

Test the serial port flow control.

Test Time: Up to 5s

403 - External Loopback

Transmit and receive data externally at various speeds.

Test Time: Up to 10s

404 - Internal Loopback

Transmit and receive data internally at various speeds.

Test Time: Up to 10s

405 - FIFO

Test the serial port first in, first out buffers at various speeds.

Test Time: Up to 8s

406 - Divisor Clock

Test the serial port divisor clock.

Test Time: Up to 25s

407 - Endurance

Test the serial port endurance.

Test Time: User defined

Error Codes

Error Code	Name
0x00/3FF	The test cannot be executed because something is not supported
0x01/3FF	The specific serial test failed

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF 0x01/3FF	No capabilities to perform the test.

5502 - Processor

Overview

This group test the processor or processors. The tests confirm the correct operation of both the base, or core, behaviour and the various instruction set extensions supported such as SSE.

The tests are designed to look for anomalous behaviour while processing test sequences and data that are assembled on the fly. The testing approach ensures availability of all register and instruction combinations using a large volume of test data against a model for the expected behaviour. There are tests for the integer and floating point instructions, plus tests for vector instructions.

The group also includes tests for symmetric behaviour, such as ensuring cores execute at similar speeds or that local cache content can remain synchronised during heavy loading from all cores.

Note: Each device identified by this group represents a physical processor package (socket).

Note: Each set of tests when selected are executed on every applicable processor core / hardware thread (SMT).

Tests

Test	Name	I	E	M	T
401	Core Instruction Set				
402	Floating Point Instruction Set				
403	SSE Instruction Set Test				
404	SSE2 Instruction Set Test				
405	SSE3 Instruction Set Test				
406	SSSE3 Instruction Set Test				
407	SSE4 Instruction Set Test				
409	Pairing Symmetry				
410	Execution Symmetry				
411	Cache Coherency				

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	Test only the bootstrap CPU thread
402	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	
403	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	
404	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	
405	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	
406	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	
407	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	
409	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	
410	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	
411	1	Test Bootstrap processor only	FALSE	FALSE	TRUE	

Descriptions

401 - Core Instruction Set

This test performs certain CPU operations and checks the results against expected results. The CPU Test is made up of the following categories:

General: Loads registers with patterns, performs operations that affect certain flags, and then checks to see that everything is operating correctly.

Arithmetic: Performs various addition, subtraction, multiplication, and division operations and verifies against expected results.

Logic: Tests shift and rotate instructions.

402 - Floating Point Instruction Set

Tests of the numeric coprocessor instructions to check for correct operation. The operation is compared to the expected result. A failure indicates a variance to the expected result.

403 - SSE Instruction Set Test

This test performs SSE operations and checks the results against model results. The CPU Test performs following kind of SSE operations: Integer arithmetic; logic, comparison operations, Float arithmetic; logic, comparison operations.

404 - SSE2 Instruction Set Test

This test performs SSE2 operations and checks the results against model results. The CPU Test performs following kind of SSE2 operations: Integer arithmetic; logic, comparison operations, Float arithmetic; logic, comparison operations.

405 - SSE3 Instruction Set Test

This test performs SSE3 operations and checks the results against model results. The CPU Test performs following kind of SSE3 operations: Float add, subtract, move, duplicate, truncate operations.

406 - SSSE3 Instruction Set Test

This test performs SSSE3 operations and checks the results against model results. The CPU Test performs following kind of SSSE3 operations: Sign negate, add, subtract, shuffle, align operations.

407 - SSE4 Instruction Set Test

This test performs SSE4 operations and checks the results against model results. The CPU Test performs following kind of SSSE3 operations: Conditional copy, sign manipulation, insert / extract, min / max, sign extension, data rounding operations.

409 - Pairing Symmetry

This test evaluates and tests the CPU stepping symmetry.

410 - Execution Symmetry

This test evaluates and tests the CPU execution performance symmetry.

411 - Cache Coherency

This test evaluates and tests the CPU cache coherency.

Error Codes

Error Code	Name
0x00/3FF	The test for this processor cannot be executed because it is not supported
0x01/3FF	Failed Floating point instructions test
0x02/3FF	Failed Core sign bit test
0x03/3FF	Failed Core carry bit test
0x04/3FF	Failed Core zero bit test
0x05/3FF	Failed Core parity bit test
0x06/3FF	Failed Core RCX register test
0x07/3FF	Failed Core RDX register test
0x08/3FF	Failed Core R8 register test
0x09/3FF	Failed Core R9 register test
0x0A/3FF	Failed Core shift left test
0x0B/3FF	Failed Core shift right test
0x0C/3FF	Failed Core addition test
0x0D/3FF	Failed Core subtraction test
0x0E/3FF	Failed Core multiplication test
0x0F/3FF	Failed Core division test
0x10/3FF	The Enabled and available CPU cores do not match
0x11/3FF	The Enabled CPU core is reported as being unhealthy
0x12/3FF	The application processor timed out
0x13/3FF	The Assembler failed to parse instructions, or no Assembler was defined to handle an instruction.
0x14/3FF	Emulated result did not match to the result of the code executed on the core.
0x15/3FF	A memory allocation error.
0x16/3FF	The Enabled CPU failed a CPUID request
0x17/3FF	The CPU core pairing symmetry failed
0x18/3FF	The CPU core execution symmetry failed
0x19/3FF	The CPU cache coherency failed
0x1A/3FF	Failed to create an event
0x1B/3FF	Non-Blocking mode does not function correctly

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF	The processor does not have the capabilities to perform the test.
0x01/3FF 0x02/3FF 0x03/3FF 0x04/3FF 0x05/3FF 0x06/3FF 0x07/3FF 0x08/3FF 0x09/3FF 0x0A/3FF 0x0B/3FF 0x0C/3FF 0x0D/3FF 0x0E/3FF 0x0F/3FF 0x14/3FF 0x17/3FF 0x18/3FF 0x19/3FF 0x1A/3FF 0x1B/3FF	Potential processor silicon failure.
0x10/3FF 0x11/3FF 0x12/3FF 0x16/3FF	Processor core management error - potential hardware fault.
0x13/3FF 0x15/3FF	Test internal error - system resources may be low.

6202 - Optical

Overview

This group provides tests optical media devices. Optical device that can be tested are CD-ROM, DVD or Blu-ray drives. There are tests to cover both the mechanical and data read capabilities of the drives from the pre-boot environment. If required, data write tests are available in the Windows diagnostics suite.

Note: Requires suitable data disc media appropriate to the drive type and operating mode to be tested (CD, DVD or Blu-ray).

Note: 'ROM' Data Only Media must be used and ideally of near total capacity to ensure full travel of the device head during tests.

Tests

Test	Name	I	E	M	T
401	Linear Read			•	
402	Random Read			•	
403	Butterfly Seek			•	

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	1	Duration	0	0	604800	Time to run the test for in seconds
	2	Coverage	100	1	100	Percentage coverage
	3	Maximum Errors	1	1	50	Continues to test until the maximum number of errors is reached. These are only errors directly associated with reading the drive.
402	1	Duration	300	1	604800	
	3	Maximum Errors	1	1	50	
403	1	Duration	0	0	604800	
	2	Coverage	100	1	100	
	3	Maximum Errors	1	1	50	

Descriptions

401 - Linear Read

Exercises a drive's read capability using linear (incrementally increasing) read addresses. Success or failure of each read is monitored.

402 - Random Read

Exercises a drive's read capability using pseudo-random read addresses (these are randomly generated using a fixed computational process). A quick benchmark is performed on the device to determine a read rate. Success or failure of each read is monitored.

403 - Butterfly Seek

Each Butterfly Seek test iteration consists of two seeks: one seek is lower than (below) the middle sector and one seek is higher than (above) the middle sector. After each iteration, the lower seek position increases and the higher seek position decreases by the same amount.

Error Codes

Error Code	Name
0x00/3FF	The test cannot be executed because something is not supported
0x01/3FF	Device ID unknown (Exceeds array depth)
0x02/3FF	Device is too small to test
0x03/3FF	Device read failed

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF 0x01/3FF 0x02/3FF 0x03/3FF	No capabilities to perform the test.

7002 - Solid State Drives

Overview

This group is for solid state drives (SSD). A SSD is a data storage device that uses solid state memory to fulfil the role that a hard disk drive (HDD) would traditionally provide in a system.

SSDs are distinguished from traditional magnetic disks, HDDs, which are electromechanical devices containing spinning disks and movable read-write heads. By contrast, SSDs retain data in flash memory chips and so contain no moving parts. Compared to HDDs, SSDs are typically less susceptible to physical shock, are silent, have lower access time and latency, but lower capacity.

To act as drop in replacements for HDDs, many SSDs use the same interfaces as hard disk drives, but higher performance SSDs require dedicated connection types such as NVMe. Lower capacities mean SSDs are often fitted alongside a regular HDD to provide a boot volume for rapid OS start times.

Tests

Test	Name	I	E	M	T
401	Linear Read				
402	Random Read				
403	S.M.A.R.T. Immediate Test				
404	S.M.A.R.T. Short Self Test				
405	S.M.A.R.T. Extended Self Test				
406	Internal Cache				
407	S.M.A.R.T. Conveyance				

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	1	Duration	0	0	604800	Time to run the test for, seconds, maximum 1 week
	2	Coverage	100	1	100	Percentage coverage
	3	Maximum Errors	1	1	50	Continues to test until the maximum number of errors is reached. These are only errors directly associated with reading the drive.
402	1	Duration	300	1	604800	
	3	Maximum Errors	1	1	50	
403	4	S.M.A.R.T Diagnostic Threshold	100	1	10000	Specifies the maximum permitted error count in the comprehensive S.M.A.R.T error log.
	5	Ignore S.M.A.R.T Error Log	FALSE	FALSE	TRUE	Specifies any error count in the comprehensive S.M.A.R.T error log will be ignored.

Descriptions

401 - Linear Read

Exercises a drive's read capability using linear (incrementally increasing) read addresses. Success or failure of each read is monitored.

402 - Random Read

Exercises a drive's read capability using pseudo-random read addresses (these are randomly generated using a fixed computational process). Success or failure of each read is monitored.

403 - S.M.A.R.T. Immediate Test

This test checks the status of S.M.A.R.T. to ensure that the SSD is in reliable condition. If at least one S.M.A.R.T. attribute is below the threshold, the test fails.

Test Time: 2 to 10s

404 - S.M.A.R.T. Short Self Test

This test launches and monitors a S.M.A.R.T. Short Self-Test.

Test Time: Approx 2 minutes.

405 - S.M.A.R.T. Extended Self Test

This test launches and monitors a S.M.A.R.T. Extended Self-Test. A longer and more thorough self-test with no time limit.

Test Time: From several minutes to several hours.

406 - Internal Cache

Tests the SSD Internal Cache or Buffer Memory.

407 - S.M.A.R.T. Conveyance

This test launches and monitors a S.M.A.R.T. Conveyance Self-Test.

Intended as a quick test to identify damage incurred during transporting of the device from the drive manufacturer to the computer manufacturer.

Test Time: Several minutes but is device dependent.

Error Codes

Error Code	Name
0x00/3FF	Device ID unknown (Exceeds array depth)
0x01/3FF	Device is too small to test
0x02/3FF	Device read failed
0x03/3FF	S.M.A.R.T. interface not supported
0x04/3FF	S.M.A.R.T. disabled or not supported by device
0x05/3FF	S.M.A.R.T. failed
0x06/3FF	Requested S.M.A.R.T. test not supported by device
0x07/3FF	ATA Pass through identify device failed
0x08/3FF	ATA device does not support power features
0x0A/3FF	Standby immediate test failed
0x0B/3FF	Device write failed
0x0C/3FF	Read written data mismatch
0x0D/3FF	A S.M.A.R.T. attribute reached or below the acceptable threshold value
0x0E/3FF	A S.M.A.R.T. comprehensive log error count at or exceeding the acceptable limit

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF 0x01/3FF 0x02/3FF 0x04/3FF 0x05/3FF 0x07/3FF 0x0A/3FF 0x0B/3FF 0x0C/3FF 0x0D/3FF 0x0E/3FF	The device may be faulty.
0x03/3FF 0x06/3FF 0x08/3FF	The device does not appear to support this test. Check the test descriptions manual for the test requirements.

7702 - System Block Device

Overview

Provides testing for block based system storage that has only limited BIOS support during the pre-boot phase. Typically this will be embedded flash memory that does not connect via a traditional disk bus such as SATA, SCSI or USB. A typical examples might be eMMC in systems with a mobile form factor.

Tests

Test	Name	I	E	M	T
401	Linear Read				
402	Random Read				

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	1	Duration	0	0	604800	Time to run the test for in seconds
	2	Coverage	100	1	100	Percentage coverage
	3	Maximum Errors	1	1	50	Continues to test until the maximum number of errors is reached. These are only errors directly associated with reading the drive.
402	1	Duration	300	1	604800	
	3	Maximum Errors	1	1	50	

Descriptions

401 - Linear Read

Exercises a drive's read capability using linear (incrementally increasing) read addresses. Success or failure of each read is monitored.

402 - Random Read

Exercises a drive's read capability using pseudo-random read addresses (these are randomly generated using a fixed computational process). A quick benchmark is performed on the device to determine a read rate. Success or failure of each read is monitored.

Error Codes

Error Code	Name
0x00/3FF	The test cannot be executed because something is not supported
0x01/3FF	Device ID unknown (Exceeds array depth)
0x02/3FF	Device is too small to test
0x03/3FF	Device read failed

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF 0x01/3FF 0x02/3FF 0x03/3FF	No capabilities to perform the test.

7802 - NVMe Drives

Overview

This group is for NVMe solid state drives. An NVMe (sometimes NVM Express) drive is a data storage device that uses solid state memory to fulfil the role that a hard disk drive (HDD) would traditionally provide in a system. NVMe drives use direct connection to the system PCI Express bus to achieve higher data transfer speeds than other solid state drives (SSD) that connect via SATA.

NVMe drives are distinguished from traditional magnetic disks, HDDs, which are electromechanical devices containing spinning disks and movable read-write heads. By contrast, NVMe drives retain data in flash memory chips and so contain no moving parts. Compared to HDDs, NVMe drives are typically less susceptible to physical shock, are silent, have lower access time and latency, but lower capacity.

Lower capacities mean NVMe drives are often fitted alongside a regular HDD to provide a boot volume for rapid OS start times.

Note: Pre-boot NVMe drive tests require system BIOS support.

Tests

Test	Name	I	E	M	T
401	Linear Read				
402	Random Read				
403	Internal Cache				
404	S.M.A.R.T Health Test				

Parameters

Test	Parameter	Name	Default	Min	Max	Note(s)
401	1	Duration	300	0	604800	Time to run the test for, seconds, maximum 1 week
	2	Coverage	100	1	100	Percentage coverage
	3	Maximum Errors	1	1	50	Continues to test until the maximum number of errors is reached. These are only errors directly associated with reading the drive.
402	1	Duration	300	1	604800	
	3	Maximum Errors	1	1	50	
404	4	Check Read Only State	TRUE	FALSE	TRUE	When specified, the test shall fail if the device has been demoted to read only status
	5	Maximum Data Integrity Errors	5000	1	0xffffffff	Data integrity threshold
	6	Life Threshold	90	1	255	Remaining life threshold

Descriptions

401 - Linear Read

Exercises a drive's read capability using linear (incrementally increasing) read addresses. Success or failure of each read is monitored.

402 - Random Read

Exercises a drive's read capability using pseudo-random read addresses (these are randomly generated using a fixed computational process). Success or failure of each read is monitored.

403 - Internal Cache

Tests the NVMe drive internal cache or buffer memory.

404 - S.M.A.R.T Health Test

This test checks the S.M.A.R.T. health status to ensure that the NVMe drive is in reliable condition. If at least one S.M.A.R.T. attribute is below the threshold, the test fails.

Error Codes

Error Code	Name
0x00/3FF	Device ID unknown (Exceeds array depth)
0x01/3FF	Device is too small to test
0x02/3FF	Device read failed
0x03/3FF	ATA Pass through identify device failed
0x04/3FF	ATA device does not support power features
0x05/3FF	Standby immediate test failed
0x06/3FF	Device write failed
0x07/3FF	Read written data mismatch
0x08/3FF	S.M.A.R.T. Health data is unavailable
0x09/3FF	S.M.A.R.T. Health check failed with critical warnings
0x0A/080	S.M.A.R.T. estimated life outside of tolerance.
0x0B/080	S.M.A.R.T. data integrity errors outside of tolerance.
0x0C/3FF	S.M.A.R.T. NVMe reliability failure detected.
0x0D/3FF	S.M.A.R.T. volatile memory failure detected.
0x0E/080	S.M.A.R.T. drive capacity failure detected.
0x0F/3FF	S.M.A.R.T. temperature failure detected.
0x10/3FF	S.M.A.R.T. drive read only state detected.

Troubleshooting

Error Code(s)	Potential Reason
0x00/3FF 0x01/3FF 0x02/3FF 0x03/3FF 0x05/3FF 0x06/3FF 0x07/3FF 0x09/3FF 0x0A/080 0x0B/080 0x0C/3FF 0x0D/3FF 0x0E/080 0x0F/3FF 0x10/3FF	The device may be faulty.
0x04/3FF 0x08/3FF	The device does not appear to support this test. Check the test descriptions manual for the test requirements.

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